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HIGH STRENGTH GLASS FIBERS DEVELOPMENT PROGRAM

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HIGH STRENGTH GLASS FIBERS DEVELOPMENT PROGRAM
FOURTH PROGRESS REPORT - November 25, 1961

SUMMARY

Equipment check out and refinement has accounted for most of the effort during the past month. The spooler has been run successfully at speeds up to 1800 rpm. This corresponds to a linear drawing speed of 5,660 ft. per minute. This machine serves both to draw the glass filament and later to provide a controlled speed rewinding of the resin-coated filament into test rings. Initial testing of the glass melting furnace resulted in the failure of one resistance heating coil which is being repaired. Preliminary specifications have been decided for the resin to be used in coating the newly formed glass fiber.

DETAILED PROGRESS DURING REPORTING PERIOD

Spooler

Assembly of the spooler machine is now 95% completed. The electrical connections to the various controls constitute the principal remaining work to make this machine fully operative. Prior to the receipt of the speed-controlled drive motor, the mechanical operation of the spooler was checked out by making use of a constant speed motor running at 1800 rpm. This corresponds to a peripheral speed on the spools of 5,660 ft. per minute, which is in the range contemplated for drawing the glass monofilaments from the melt. Figure 1 is a photograph of the spooler machine with all of its guards removed to show the gearing arrangements which allow the various motions of which the device is capable. The two spindles are shown in position on the turntable. On the upper spindle is one of the black anodized aluminum sleeves on which the actual filament winding will take place. Figure 2 shows the turntable being rotated to bring the filled spool into the lower position for unloading while the other spool moves into position to pick up the glass fiber. In actual operation the second spool would, of course, also carry a black anodized sleeve.

Furnace

During the initial heating up of the furnace, without glass charge, a break occurred in one of the platinum-rhodium alloy resistance heating coils. Dis-assembly of this portion of the furnace and examination of the area of the break indicated that the failure was most likely caused by a flaw in the wire and not by overheating. Additional wire has been ordered and the furnace will be repaired and ready for a new check-out within a few days.

Choice of Resin for Coating Filament

In a filament wound structure, such as a rocket case, one of the functions of the resin component is that of transmitting stress between glass fibers so that the total load is distributed over the total available resisting material. To perform this function, therefore, the resin should have sufficient coupling to the fiber, either chemically or mechanically, and a high enough strength in shear so that the resin does not fail before a high stress level can be produced in the glass fiber. One usually finds that rigid resins, i.e., those with high tensile modulus, are employed because such resins seem to be the ones with superior tensile strength. The elongation of such resins is commonly reported as 3 to 4%. However, if one considers the resin to become bonded to the glass at an elevated temperature during cure, the difference in thermal expansion coefficients between the glass and the resin will cause

the resin to become strained by a substantial amount upon cooling to room temperature. It can easily be shown that for normal cure schedules used with common epoxy resin-hardener combinations, the thermal effect can account for at least one-half to three quarters of a percent of elongation in the resin. The remaining extensibility of the resin, which is brought into play when the composite is subjected to external load, may therefore be reduced below 3%. Since this is approximately the maximum elongation for E-type fiberglass, it is apparent that in the presence of any appreciable stress-concentrating influences in the resin, it is quite possible for the resin to fail before the glass fibers have reached their maximum extensibility. This does not make optimum use of the glass reinforcement. Furthermore, since it is believed that cracks originating in a resin which is firmly bonded to a glass fiber will propagate into the glass fiber and cause it also to fail, one should do well to consider ways of avoiding the premature failure of the resin matrix in tension.

In accordance with the above reasoning, we plan to employ as coating resin for the glass monofilaments, a material which will have a somewhat higher extensibility than the commonly employed low molecular weight epoxy resin cured with aromatic diamines, but which also retains relatively high tensile strength and hardness.

FUTURE WORK

Repair of the furnace and removal of the spooler machine from the shop to the environmental control chamber within the next few days will make it possible for us to begin our fiber drawing operations early in December.

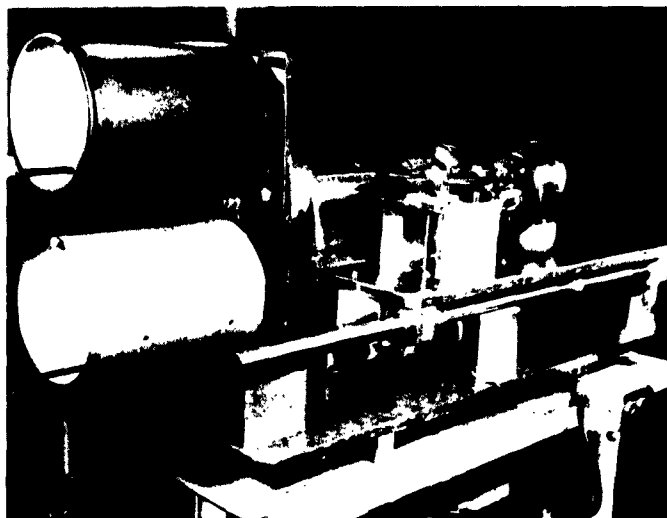


Figure 1



Figure 2